High Resolution MRI of the Human Hippocampus at 4.7 Tesla

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Introduction

The hippocampus is involved in a number of neurological disease states. Hippocampal volume changes resulting from neuronal loss have been associated with various neurodegenerative disorders including, for example, Alzheimer's disease[1]. Prolonged temporal lobe epileptic seizures are associated with mesial temporal sclerosis also resulting in damage to the hippocampi and reduced hippocampal volumes[2]. The MRI monitoring of these conditions involves *inter alia* volumetric measurement and bilateral comparisons of the hippocampi. Recently we have shown that Fast Spin Echo (FSE) imaging on our 4.7 T MRI system will produce good quality images with an in-plane resolution of approximately 500 μm with a 2 mm slice thickness[3]. Coronal slices through the hippocampus at these image resolutions show detailed inner structure and layers. This structural detail is not observed at lower image resolution because of its small size and at lower field strengths due to the inferior signal-to-noise. Observation of the detailed inner structure of the hippocampi might give useful information to be used in conjunction with volumetric measurements. Here we describe the imaging of the hippocampus using a protocol as described above and using thinner 1 mm slices.

Experimental

FSE images (8 echoes) were obtained on a 4.7 Tesla, 90 cm bore-diameter magnet (Magnex Ltd, Oxford, UK) controlled by a console supplied by Philips Medical Systems (Eindhoven, The Netherlands), based on a MR5000 design by SMIS Ltd (Guildford, UK). A shielded head gradient coil was used providing gradient fields of up to 36 mTm^{-1}. Images were acquired using a quadrature birdcage RF coil of 28 cm internal diameter (PulseTeq, Guilford, UK). Seventeen slices were obtained with a repetition time (TR) of 4 s. Along the read axis, 512 points were acquired (sampling bandwidth 50 kHz) and 384 phase encoding (*pe*) steps were performed (with a factor of two oversampling) resulting in a total acquisition time of approximately 5.5 minutes.

Results and Discussion

The subject for these studies is a neurologically normal adult male (age 49 years). Figure 1a shows a full coronal slice through the brain with the red box indicating a region around the hippocampus indicating the expanded regions. **Figure 1b** is the expanded left hippocampal region at 2 mm slice thickness. The hippocampus shows a number of substructure layers. The 1 mm slice (**Figure 1c)** still shows the layering structure but it is less clear due to the decreased SNR that results from imaging smaller voxel sizes. **Figure 1d** is the same slice as shown in **Figure 1c**, however, a novel noise filter was applied[4]. The in-plane resolution of the FSE images is degraded by the point spread function, and by the T2 relaxation of the signal during the eight echo train. The filter smoothes the data along the read axis so that the in-plane resolution is isotropic, with the added benefit of increasing the SNR.

Conclusions

We have shown that our 4.7 Tesla MRI system can produce high resolution images of small deep brain structures such as the hippocampus. These imaging and filtering modalities will be very useful in studying brain diseases that affect the hippocampus where there is neuronal loss so that more precise longitudinal studies can be carried out.

Acknowledgments

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References

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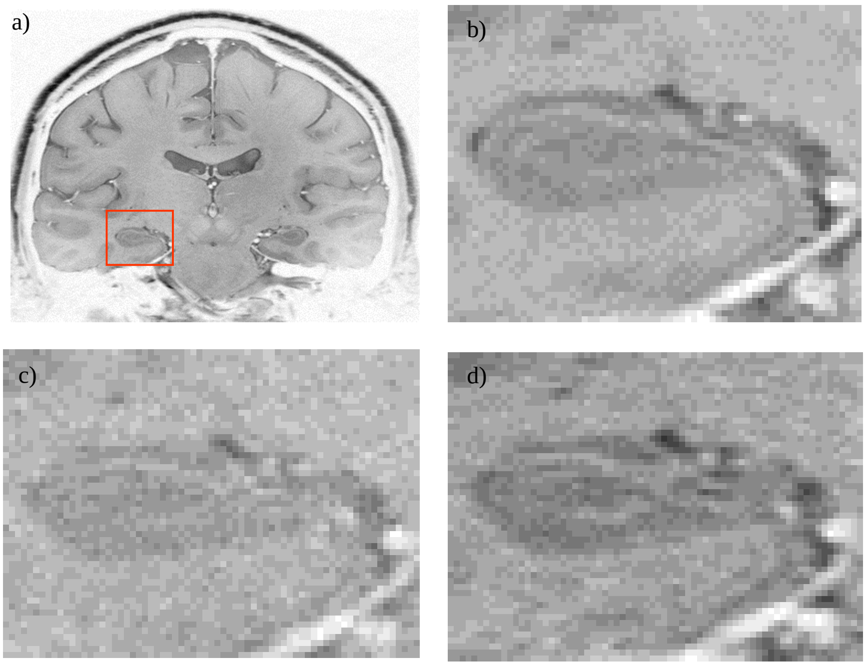

Figure 1a) is a FSE coronal slice (2 mm with 0.5 mm in-plane resolution) through the brain. The red box shows the region around the hippocampus expanded in **b)**. A 1 mm FSE slice with the same in-plane resolution is shown in **c)**. A novel noise filter was used to increase the SNR in **d)**.